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Election Technology and the Voting Experience in 2008

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The 2000 election brought the issue of voting machine performance to national attention. According to the Caltech/MIT Voting Technology Project (2001), up to 2 million votes were lost in 2000 owing to problems associated with faulty voting machines and confusing ballots. Stewart (2006) estimated that one million votes were "recovered" in the 2004 presidential election because of the Help America Vote Act's (HAVA) requirement that punch card ballots and lever machines be replaced by more modern optically scanned ballots and direct recording electronic (DRE) voting machines.

The role of technology in guarding the franchise in the United States has grown even more controversial since 2000. Most notably, a large number of computer scientists and election reform activists have identified what they perceive to be inherent security vulnerabilities associated with DREs (Mercuri 1992; Neumann 1985, 1990, 1993; Howland 2004; Dill 2003; Rubin 2003; Kohno, et al 2004). This alarm has spread more broadly to a large portion of the electorate, leading to efforts nationwide to ban electronic voting that lacks a "paper trail" (Alvarez and Hall 2008). More broadly, regular citizens, activists, and election professionals have become concerned with the performance of different voting technologies from a time-and-motion and/or human factor perspective. Among these concerns are issues like the lifetime cost of different technologies, the ease of use of technologies, and the throughput capacity of different types of voting machines.

Given the concerns that have been raised about the performance of voting technologies, it is remarkable how little empirical evidence has been adduced concerning the performance of

voting machines nationwide (Stewart 2008; Alvarez and Hall 2008; Gerken 2009). This is not to say that there is *no* evidence about voting system performance, only that the evidence is surprisingly thin. There is now a line of "residual vote" scholarship, which uses over- and under-votes as a proxy for the ease-of-use of different equipment (Ansolabehere and Stewart 2005; Herron and Sekhon 2005; Stewart 2006; Leib and Dittmer 2002; Ansolabehere 2002; Buchler, Jarvis, and McNulty 2004; Brady 2004; Kimball and Kropf 2005; Frisina, Herron, Honaker, and Lewis 2008). Some have studied human factors issues as they pertain to voting machines in experimental and quasi-experimental settings (Herrnson, et al; Everett, Byrne, Greene, and Houston 2006; Byrne, Greene, and Everett 2007; Lausen 2007). And yet others have used survey techniques to explore the satisfaction of voters with different types of voting technologies (Alvarez, Hall, and Llewelyn 2004, 2008).

The purpose of this paper is to add to the growing literature about how well voting technologies perform in elections, using survey research to gather direct voter feedback. In particular, I use the 2008 Survey on the Performance of American Elections, combined with data about the voting machines used by voters, to assess whether different machines led voters to experience more problems voting or to have less confidence in how elections were run in 2008.

I explore two issues that pertain to the voter experience and voter technologies. The first is whether users of specific voting machines encountered more problems than the users of other types of machines. Practically speaking, this reduces to the question of whether voters who used optical scanning technologies to vote had more (or fewer) problems than those who used DREs in 2008. The second issue is whether voter confidence in the quality of the vote-count varied with the use of different voting machines.

I find that voters who used both DREs and optical scanners had very few problems with voting equipment in 2008, and that the experience of both sets of voters was similar, as far as encountering problems is concerned. The one problem that affected users of voting machines at different rates was in how long they waited in line to vote. DRE voters waited an average of 21 minutes to vote on Election Day, compared to 12 minutes for optical scan voters. There is evidence that most of this difference was not due to the DREs themselves, but to the fact that DREs tend to be used more often in cities and communities that have large African American populations — areas that may already be suffering from problems with the delivery of government services.

I also find that users of DREs were less confident that their votes were counted as cast, compared to users of other voting equipment. There was also an interaction between political ideology and voting machine type in influencing one's confidence in the quality of the vote count. Liberal voters who used DREs were particularly skeptical that their votes had been counted as cast.

The rest of the paper proceeds as follows. First, I briefly describe the 2008 Survey of the Performance of American Elections. The following section explores the relationship between voting machine usage and the qualitative experience voting. Then I examine the influence that voting machine type had on voter confidence in the quality of the vote count. The final section concludes.

I. Survey Design

The primary data for this paper come from the 2008 Survey of the Performance of American Elections.[1] The purpose of the survey was to investigate a range of election administration issues nationwide in 2008. In order to facilitate comparisons, the number of interviews was constant in each state — 200. Therefore, the total number of observations in the entire data set is 10,000.

The survey was administered via the Internet by YouGov/Polimetrix. Full details of the survey may be found at Alvarez, et. al (2009). The survey went into the field the Wednesday following Election Day, finishing up within ten days.[2]

The most salient aspect of the survey that may be of concern in this paper is the fact that it was administered via the Internet. One goal of the entire project of which this paper is a part is to understand whether there are "mode effects" when conducting election administration surveys. To address the question about mode effects, the survey also involved a telephone portion, in which 200 respondents were interviewed in each of 10 states, using the same questionnaire. As a general matter, respondents to the Internet survey were slightly younger and wealthier than the phone respondents. For the most part, Internet respondents did not report dramatically different experiences voting than did Internet respondents. When they were different, it was usually because Internet respondents were more likely to report that their

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[1]Funding for this project was generously provided by the Pew Center on the States, the JEHT Foundation, and AARP. The funding agencies bear no responsibility for the analysis presented here.

[2]In preparation for the November 2008 survey, we also conducted two pilots, which studied the three gubernatorial elections that were held in November 2007 and the fifteen states that held primaries during Super Tuesday in 2008.

experiences were negative when they went to vote. While the comparison of the two modes still needs further investigation, it does not appear that the covariate patterns differ in the two modes. A fuller discussion of the differences between the Internet and telephone respondents is available in Alvarez, et al (2009).

II. Voting Machines and Problems at the Polls

The most basic question to explore is whether voters were more or less likely to encounter different problems voting, as a function of the voting machines they used. Voting machines themselves vary in their ease of use, which may show up in the survey responses (Herrnson, et al, 2008). Voting machines differ also in how they are deployed in precincts, and the resulting workflow required by one type of machine may have spillover effects on the voting experience. For instance, because DREs are much more expensive to purchase than optical scanners, it is much more expensive to add an additional voting station to a precinct that has DREs when turnout increases. That, in turn, could produce longer lines to vote in areas that use DREs, compared to areas that rely on optical scanners. Or, because optical scanners require pre-printed ballots, a mis-estimate of turnout could result in a shortage of ballots, a problem that does not vex DREs.

Therefore, I begin the analysis by asking simply whether users of different types of machines were more likely to encounter problems in 2008 of the following sort:

- having problems with the equipment itself
- finding it difficult to find the polling place
- encountering a poorly run polling place or a poorly performing poll worker

- encountering a voter registration problem
- waiting in a long line to vote

Table 1 provides measures of how often respondents encountered particular problems, as a function of the type of voting equipment they used. The voting equipment data were purchased from Election Data Services (EDS). EDS reports the voting machine used for in-person voting in each county in the U.S. Sometimes municipalities within a county will use a multitude of different types of voting machines. Because the voting equipment data are reported at the county level, respondents from these counties are recorded as voting on "mixed" machines in 2008. Finally, because I am interested in the machines used when voters vote in person, I confine the analysis to respondents who either voted on Election Day or who voted early at a walk-in early voting center.

[Table 1]

Table 1 tests whether the responses to questions about the different types of problems differed across voting machines, using a series of ANOVA analyses. The most obvious item to examine is whether users of different voting machines experienced problems at different rates. The "voting equipment problem" item is the only item in the table in which there were no differences across voting machines.

There were, at most, minimal differences in the rates of encountering problems across voting machine types, with one exception — waiting in line. Respondents who voted on DREs waited almost twice as long to vote as users of scanned paper ballots.[3] This confirms a concern

[3]The line length question was recoded, so that the response represented the nominal midpoint of the response category. For instance, respondents who stated they waited between 30 minutes and an hour are coded as waiting 45 minutes. Respondents who stated that they waited

some have raised about DREs, which is that they are often under-deployed where they are used, because of the cost, and that this results in longer lines and greater inconvenience for voters.

One question that arises with the issue of line length is *where* precisely the backup occurred. Lines may generally occur in two places at a precinct — at the table to check-in voters or at the machines themselves, after the voters have checked in but are waiting to gain access to a voting booth. Users of DREs may be doubly disadvantaged, since part of the check-in is the preparation of a Personal Electronic Ballot (PEB) card, which allows the voter to vote and renders the proper ballot style.

To probe this detail, the survey asked voters who had to wait in line, the following question: "Was your wait in line mostly when you first arrived to check in at the registration table, or after you checked in and were waiting to gain access to a place to cast your ballot?" A summary of answers to this question, by voting machine type, is given in Table 2.

[Table 2]

There were slight differences between DREs and optical scanners in where the lines occurred. Lines were a little more likely to appear gaining access to the ballot/voting station with optical scanners than with DREs. However, the difference was substantively very small, and unlikely to be the source of the big differences encountered in waiting to vote.

African Americans waited in line twice as long to vote, compared to whites. The average reported wait was 27 minutes for Blacks and 13 minutes for Whites. This is not a difference

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"longer than an hour" to vote were coded as having waited 122 minutes. The coding of 122 minutes was chosen for the top category because respondents picking this response were prompted to report precisely how many minutes they waited. The average of these open-ended responses was 122 minutes.

unique to 2008. It showed up in the two pilot studies associated with this project. In the three states studied in the gubernatorial elections in November 2007 (Kentucky, Louisiana, and Mississippi), Blacks waited an average of 6 minutes to vote, compared to 2 minutes for whites. In the fifteen states studies on Super Tuesday, Blacks waited an average of 5 minutes to vote, compared to 4 minutes for Whites. And in the 2006 CCES, Blacks waited an average of 12 minutes to vote, compared to 7 minutes for Whites.

For some, this is a sign of how poorly African American communities are served by election administrators, as is often true with other government services. However, African Americans were more likely to vote on DREs in 2008 than Whites. While I have not examined the situation for the earlier elections covered by this project or in 2006, it is likely that African Americans were more likely to vote on DREs in these elections, too. Therefore, the racial difference observed in this and prior studies, and reported widely by the press, may really be a story about DREs, not racial discrimination, *per se.*

To understand whether racial disparities in waiting in line to vote were due to the disproportionate use of DREs by African Americans, I conducted a simple multivariate regression analysis that predicted the amount of time waiting to vote as a function of the racial composition of the respondent's ZIP code and the population density of the ZIP code. The results are reported in Table 3. The analysis is confined to voters who voted on Election Day who used either DREs or optical scanners.

[Table 3]

The first three columns of Table 3 reveal the bivariate regression coefficients. In the multivariate regression (column 4), the size of the DRE coefficient falls by roughly one-third,

while the coefficients associated with the racial composition of the neighborhood and its density fall by much smaller amounts. Finally, in the regression that introduces state-level fixed effects, the DRE coefficient is cut in half, and the coefficient now does not meet the $p < .05$ criterion. The other two coefficients change by much smaller amounts.

What this suggests is that the racial effect is fairly robust, whereas the DRE effect is most likely due to the use of DREs in predominantly African-American areas and in cities. The reduction in the coefficient's size when we introduce state-level fixed effects also suggests that the bivariate DRE effect may be mostly due to other factors that figure into how states that allow DREs manage their elections.

III. Voting Machines and Voter Confidence

In addition to understanding whether voting machines get in the way of voters trying to express their preferences, the machines themselves have become the target of political controversy. At the activist level the debate has largely arrayed along a left-right continuum, with the left being highly suspicious of DREs — and in some cases, even of the scanners used to read optically scaned ballots — and the right ranging from indifference to mild support for DREs. Distrust on the left has spilled over into voter mobilization efforts, as some activists have encouraged Democratic supporters to vote absentee, on a paper ballot, rather than on a hackable "black box" machine.

We can use the survey to test the degree to which the ideological battle over voting machines has percolated down to voters. The survey asked all respondents "How confident are you that your vote in the General Election was counted as you intended?" The response

categories were “very confident,” “somewhat confident,” “not too confident,” and “not at all confident.”

A simple glance at the marginals suggests that if there was an influence of voting equipment on voter confidence in 2008, it was subtle. Table 4 reports the breakdown of responses to the confidence question by type of voting machine used. The differences between users of DREs and optical scanners are tiny and not statistically significant. The large difference that exists in that table is between DRE and optical scan users, on the one hand, and users of all other voting equipment, on the other. The “other” category consists of voters who used legacy systems (lever machines and hand-counted paper), plus respondents who lived in counties that used several voting machine types, which were primarily in New England and Wisconsin. Voters in these counties were considerably more confident that their ballots would be counted as cast, compared to voters who lived in counties that only used DREs or only used optical scanners.

[Table 4]

Table 5 explores whether confidence in DREs was a function of ideology. The evidence here is decidedly mixed. The most extreme ideologues actually contradict the expected pattern: “very conservative” users of DREs were *less* confident their vote was counted as cast than “very liberal” respondents. On the other hand, the plain vanilla liberals and conservatives seemed to fit the expected pattern, with liberal DRE users less confident than conservatives.

[Table 5]

Thus, a look at Tables 4 and 5 suggests that voter confidence in the count was complicated by a number of factors, including the geographic location of the voters and their

personal characteristics. If we are to find the effects of machine usage on confidence in the quality of the vote count, we need to shift to a multivariate context.

The multivariate analysis is guided by Alvarez, Hall, and Llewelyn (2008), who studied voter confidence in the 2004 election as a function of various personal demographic and political characteristics, in addition to the type of voting machine used by the voter. In that analysis, users of DREs were less confident their vote had been counted as cast, compared to those who voted on paper (mostly optical scan). Alvarez, Hall, and Llewelyn also asked respondents about their opinions of electronic voting. Not surprisingly, DRE voters who also had negative general opinions about electronic voting were *especially* skeptical that their votes were counted as cast.

The variables available to use in this analysis are not precisely those available to Alvarez, Hall, and Llewelyn. Most importantly, we do not have a direct measure of the attitudes that the respondents had toward electronic voting, *per se.* However, we did ask respondents a battery of questions to probe their attitudes about how prevalent voting irregularities were in their community. I used this battery of questions to control for general attitudes about the quality of election administration in the respondent's community.

The dependent variable was the response to the "confidence question" discussed above. It was coded so that a value of 4 corresponded with "very confident" and 1 corresponded with "not at all confident."

The demographic controls were the following:

- *age*, measured in years.
- a dummy variable equal to 1 if the respondent was *male*, zero otherwise.

- *education*, measured using a six-point scale ranging from "did not graduate high school" to "post-graduate."[4]
- *black* and *other race* dummy variables, leaving white respondents the excluded category.
- *disabled*, a dummy variable equal to 1 if the respondent stated that she or he had a health problem, disability, or handicap that kept the respondent from "currently participating fully in work, school, housework, or other activities," zero otherwise.

The control for attitudes about the honesty of local elections was constructed by using three items that asked respondents how frequently they thought voter fraud, vote theft, and voter impersonation occurred in their community. Responses were recorded on a four-point scale, ranging from "it is very common" to "it almost never occurs."[5] These three items were summed to create a scale labeled *trust*, normalized to range from 1 to 4. A value of 1 was assigned to respondents who said that all three problems were "very common" (4% of respondents) to 4, for those who said that all three problems "almost never occurred" (39% of respondents).

The political controls consisted of a mix of straightforward measures of respondent affiliations, along with variables intended to capture the interaction of the respondent's political affiliations with the outcome of the election. The political controls were the following:

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[4]The coding was 1 = did not graduate high school, 2 = high school graduate, 3 = some college, 4 = graduated with an associates degree, 5 = graduated with a bachelors degree, 6 = post-baccalaureate degree.

[5]The modal response for the voter fraud item was "it occurs occasionally" (23% of respondents); the modal response for the other two items was "it almost never occurs" (54% for vote theft and 55% for voter impersonation).

- *democrat,* coded to equal 1 for those identifying as Democrats, 0 for those identifying as independents, and -1 for those identifying as Republicans.
- *conservative,* a five-point scale ranging from 1 for those who described themselves as "very liberal" to 5 for those who described themselves as "very conservative." To preserve degrees of freedom, respondents who stated that they did not know their ideology were assigned a value of 3. The substance of the analysis does not rest on this choice, but it does affect the size of the standard errors.
- *Obama won the state*, coded to equal 1 if Barack Obama carried the respondent's home state, zero otherwise.
- an interaction term of *democrat* × *Obama won the state.*

The last variable was intended to control for respondents tending to trust the vote count more when their candidate won than when she or he lost. My expectation is that Democrats in states that Obama won will be more confident that their vote was counted as cast and that Republicans in these states will be more likely to doubt whether their vote was counted as cast.

Our dataset included people who voted on Election Day (63%), voted at early voting centers (18%) or by mail/absentee (19%). Alvarez, Hall, and Llewelyn found that absentee voters were less confident their votes had been counted as cast than in-person voters. Therefore we included two dummy variables to indicate the mode of voting in the general election, as follows:

- *absentee,* a dummy variable equal to 1 if the respondent voted absentee or by mail (i.e., in Oregon), zero otherwise.

- *early voter*, a dummy variable equal to 1 if the respondent voted early, zero otherwise.

The omitted category for these two dummy variables was respondents who voted in person on Election Day.

From the perspective of studying the influence of voting technology on voter confidence it is important to control for voting absentee, since absentee voters all use paper ballots, regardless of the mode of voting for in-person voters. Seen another way, the absentee ballot control allows us to separate out the effect of voting in person on optically scanned paper from the effect of using paper as an absentee mode.[6]

Finally, we include dummy variables to account for the type of in-person voting machine used in the county of the respondent. Unlike Alvarez, Hall, and Llewelyn, who asked respondents which type of voting machine they used, this analysis relies on data collected by Election Data Services. In addition to the obvious advantage of not having to rely on voter recall, relying on independent data measuring the voting machine used means that we can distinguish between respondents who voted on hand-counted paper ballots from those who voted on scanned paper ballots. The disadvantage is that we cannot analyze precisely voters who lived in counties that use DREs in some municipalities and paper ballots (scanned or hand-counted) in others.

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[6]Getting ahead of the analysis, absentee voters in counties that use DREs for in-person voting expressed no different confidence levels compared to other absentee voters, suggesting that attitudes associated with confidence in the election are not big motivators among those voting absentee.

Specifically, we entered two dummy variables into the analysis to account for voting machine type, leaving the optically scanned option as the omitted category:

- *dre,* equal to 1 if the county used DREs for in-person voting, zero otherwise.
- *other equipment,* equal to 1 if the county used mechanical lever machine, hand-counted paper, or a mix of equipment, zero otherwise.

Rather than simply satisfying idle curiosity, the introduction of the controls is intended to lend precision to the estimates of the voting machine effects. Therefore, it is useful to know how the controls correlated with the voting machine indicators. Based on a multivariate regression (coefficients not reported), DREs were more likely to be used by conservatives and by African Americans, and less likely to be used by states won by Obama, and by members of other races (mostly Hispanic). Users of the "other equipment" category (mostly voters in New England and Wisconsin whose counties used multiple equipment) tended to be most trusting of the results, older, Republican, liberal, and in states won by Obama. They were less likely to have voted early or absentee.

Therefore, the controls introduced should help to remove a host of confounding effects that interfere with getting a clear view of how voting technology influenced attitudes about whether the election was fairly decided.

Table 6 reports the results of the multivariate analysis. Because we are analyzing a discrete four-point scale that is clearly measuring values along a continuous latent variable, the first column uses an ordered probit analysis to study the effects. Column (2) reproduces the ordered probit analysis with OLS regression. Column (3) repeats this regression using state-level fixed effects.

[Table 6]

Leaving aside the voting machine issue for the moment, the demographic factors provide an interesting portrait of attitudes toward the outcome of the 2008 election. Respondents who were the most confident that their vote was counted as cast were (1) trustful that their local elections were clean, (2) older, (3) male, (4) well-educated, (5) Republicans, (6) African American, and (7) Democrats in states won by Obama or Republicans in states won by McCain. With one important exception, these results are consistent with those found by Alvarez, Hall, and Llewelyn. (Alvarez, Hall, and Llewelyn did not interact party with the winner of the state, however.) That exception pertains to race. In 2004, African Americans were substantially less likely to trust that their vote had been counted as cast; in 2008, they were substantially *more* confident that their vote was counted as they had cast it.

Turning to voting machines, we find that DRE-users were less confident in the quality of the vote count than users of other technologies. Again, this is consistent with the 2004 findings. Unlike the 2004 study, however, users of other voting machines were *more* confident than users of optical scanners. This remains true if we distinguish those who voted on hand-counted paper or lever machines from the grab bag "mixed" category. (Additional analysis not reported.)

One problem with the mixed category is that it may really be just an additional control for voters who lived in the Northeast and Wisconsin. To explore whether the mixed category is simply a half-hearted attempt at dummying-out individual states, I conducted a fixed-effects regression. When we do that in column (3), the results are materially the same as before, which gives me greater confidence in the results reported in the first two columns.

Alvarez, Hall, and Llewelyn reported a strong interaction between using DREs and opinions about electronic voting. While the current survey did not have a parallel question, we can treat ideology as a (weak) proxy for attitudes toward electronic voting. Therefore, I repeated the prior analysis, this time adding an interaction between the ideology measure and the indicator of DRE use. The results (reported in columns 4–6 in Table 6) are consistent with Alvarez, Hall, and Llewelyn's findings. Conservatives voting on DREs were much more confident than liberals who used them.

Keep in mind that the coefficient associated with DREs in column 4 is a combination of the direct effect and the interaction effect of ideology. For a strong conservative, therefore, the estimated probit coefficient value is $-0.46 + 5 \times 0.11 = 0.09$. For a strong liberal, the coefficient takes on a value of $-0.46 + 1 \times 0.11 = -0.35$. Thus, it is fair to say that liberals who voted on DREs were negative about their assessment of whether their vote would be counted. Conservatives, on the other hand, were largely indifferent.

IV. Conclusions

This paper confirms a growing body of research that shows that voting machines are not neutral transmission belts of voter preferences to election outcomes. Some voting machines are easier to use than others. Some voters are more convinced that certain machines are more fair than others.

Yet to note that voting technologies are not neutral is not the same thing as saying that they determine outcomes, nor does stating that voting technologies harbor shortcomings constitute a blanket indictment of elections in America (c.f. Gerken 2009). As far as voters

themselves perceive it, their experience in 2008 was very positive. The problems that they identified are focused on particular areas.

Responses to the 2008 Survey of the Performance of American Elections suggest that one place to focus is on lines at voting precincts. Users of DREs waited longer to vote in 2008 than users of optically scanned ballots, which seems to confirm criticisms leveled by opponents of DREs, who have claimed that they inherently are prone to producing back-ups. However, the detailed analysis provided in this paper suggests that the lines associated with DREs are an indicator of an even bigger problem, which is that the lines themselves seem to arise from the administrative problems facing voters in African American communities, which are more likely to have DREs.

Understanding whether longer lines associated DREs are caused by the machines themselves or by factors related to the demographic characteristics of DRE users, is critically important for the task for improving customer service in elections. A danger of simply observing that DREs are associated with longer lines is that election officials, reformers, and regular citizens might be moved to ditch DREs in favor of optically scanned paper ballots. However, if the analysis provided by this paper is accurate, then such a move would not reduce lines very much for African Americans. More important is understanding why African Americans stand in line to vote longer than whites, regardless of the machines they vote on. It is likely that major progress in reducing the lines at polling places will occur only when customer service problems associated with running polling places in African American communities are eliminated for users of all voting technologies.

This paper also confirms that the partisan polarization around the fairness of election administration may have diminished in 2008, but it hasn't disappeared altogether. The Pew Research Center for the People and the Press reported that voters in 2008 were substantially more likely to believe their vote would be accurately counted than voters in 2004, and that the partisan differences in answering this question had disappeared.[7] However, as the results of the survey analyzed in this paper demonstrate, distrust over electronic voting machines still lurks, especially among liberals who are required to use DREs. It is way too early to tell whether confidence in the vote count will continue to vary depending on the party of the winner, or whether distrust of DREs will continue to be structured along ideological lines. It is reasonable to suspect that in the next federal election in which Republicans do well, liberal distrust of DREs could return.

Gauging the performance of the election system is an important undertaking for the profession of political science. As this paper shows, common perceptions about the contours of problems facing voters may in fact be inaccurate, and thus popular proposals can easily miss the mark. In the future, as other national studies of the election process are undertaken, one can hope that systematic empirical tools will replace anecdote in identifying the nature of the problems facing voters and the most effective solutions.

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[7]The Pew Center for the People and the Press, "High Marks for the Campaign, a High Bar for Obama," November 13, 2008, http://people-press.org/report/471/high-bar-for-obama, accessed March 28, 2009.

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Table 1. Election problems and voting machine type, among voters who voted early in-person or on Election day. (Number of observations in parentheses.)

	Voting equipment problem (yes)	Finding polling place (very difficult or somewhat difficult)	How well polling place run (terrible or not well)	Voter registration problem (yes)	Line length (minutes)	Poll worker performance (poor or fair)
Punch cards	0 (10)	0 (10)	4.1% (10)	4.1% (10)	8.7 (10)	4.1% (10)
Lever machine	2.7% (507)	2.3% (506)	1.2% (506)	3.4% (507)	8.6 (507)	8.0% (506)
Paper	0 (16)	0 (15)	0 (15)	2.9% (16)	1.9 (16)	0 (15)
Scan	1.8% (4,054)	2.2% (4,063)	2.1% (4,059)	2.1% (4,053)	12.4 (4,053)	5.5% (4,057)
DRE	2.3% (2,657)	2.0% (2,561)	1.7% (2,562)	1.8% (2,570)	21.1 (2,570)	4.1% (2,567)
Mixed	1.6% (444)	0.8% (443)	0.9% (443)	0.93% (445)	6.7 (445)	3.6% (442)
Total	2.0% (7,597)	2.0% (7,598)	1.9% (7,595)	1.9% (7,601)	14.7 (7,601)	5.1% (7,598)
F	(5,7591) = .87 (p = .4975)	(5,7592) = 3.81 (p = .0019)	(5,7589) = 3.33 (p = .0053)	(5,7595) = 1.56 (p = .1673)	(5,7602) = 52.57 (p < .0001)	(5,7592) = 2.94 (p = .0119)

The columns are defined as possible:
1*Voting equipment problem* = percentage of respondents reporting a problem with the voting equipment.
2*Finding polling place* = percentage of respondents who reported that finding the polling place was “very difficult” or “somewhat difficult”
3*How well polling place run* = percentage of respondents who reported that the polling place was run “terribly” or “not well.”
4*Voter registration problem* = percentage of respondents who reported a voter registration problem.
5*Line length* = average number of minutes the respondent waited in line to vote.
6*Poll worker performance* = percentage of respondents who reported that the poll worker performance was “poor” or “fair.”

Table 2. Source of lines, by voting machine type.

	Check-in to vote	After checking in	Fairly evenly divided	N
Punch cards	68%	17%	15%	20
Lever machines	41%	36%	23%	108
Paper	30%	58%	12%	9
Scan	67%	16%	17%	2,107
DRE	59%	22%	19%	1,824
Mixed	77%	8%	14%	332

Question: Was your wait in line mostly when you first arrived to check in at the registration table, or after you checked in and were waiting to gain access to a place to cast your ballot?

<1> Most of my wait was to check in to vote.

<2> Most of my wait was after I had checked in, and I was waiting to gain access to a voting machine or other place to vote.

<3> My wait in line was fairly evenly divided between checking in and waiting to cast my ballot.

Table 3. Line length on Election Day as a function of voting machine used by respondent, racial composition of ZIP code, and population density of ZIP code. (Note: Confined to users of either DREs or opscans)

	(1)	(2)	(3)	(4)	(5)
Used DRE	6.12 (0.84)	—	—	4.74 (0.82)	2.41 (1.44)
Black percentage	—	32.72 (2.14)	—	28.52 (2.21)	21.85 (2.37)
log(population density)	—	—	1.88 (0.23)	1.11 (0.23)	1.97 (0.25)
Constant	13.35 (0.54)	12.02 (0.48)	3.73 (1.51)	3.37 (1.52)	-0.44 (1.71)
R^2	.01	.05	.02	.06	.14
N	4,573	4,573	4,573	4,573	4,573
State fixed effects	No	No	No	No	Yes

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Table 4. Confidence that vote was counted as cast, by type of voting equipment used (Election Day and early voters).

	Not at all confident	Not too confident	Somewhat confident	Very confident	N
DRE	2.1%	3.3%	23.3%	71.3%	2,541
Scan	2.0%	2.8%	21.2%	74.1%	3,995
Other	1.0%	3.2%	17.7%	78.2%	970
Total	1.9%	3.0%	21.4%	73.7%	7,506

Table 5. Confidence that vote was counted as cast, by ideology, for those using DREs.

	Not at all confident	Not too confident	Somewhat confident	Very confident	N
Very liberal	0.8%	1.1%	24.9%	73.2%	190
Liberal	2.2%	3.8%	26.7%	67.3%	391
Moderate	1.7%	3.6%	23.0%	71.7%	1,031
Conservative	3.2%	2.4%	19.3%	75.1%	658
Very conservative	2.4%	4.3%	27.1%	66.3%	354
Total	2.2%	3.3%	23.3%	71.3%	2,623

Table 6. Trust and confidence. Probability that respondent was "very confident" vote was counted as cast. Coefficients that are significant at the 95% level are in **bold**.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ordered probit	Regression	Regression (state fixed effects)	Ordered probit	Regression	Regression (state fixed effects)
Election honesty scale	**0.42** (0.02)	**0.21** (0.01)	**0.21** (0.01)	**0.42** (0.02)	**0.21** (0.01)	**0.21** (0.01)
Age (years)	**0.0089** (0.0011)	**0.0037** (0.0005)	**0.0037** (0.0005)	**0.0089** (0.0011)	**0.0038** (0.0005)	**0.0037** (0.0005)
Male	**0.11** (0.03)	**0.058** (0.014)	**0.058** (0.014)	**0.11** (0.03)	**0.057** (0.014)	**0.058** (0.014)
Education (6-point scale)	**0.027** (0.011)	0.0093 (0.0048)	0.0093 (0.0048)	**0.027** (0.011)	0.0092 (0.0048)	0.0093 (0.0048)
Democrat (3-point scale)	**-0.10** (0.03)	**-0.054** (0.017)	**-0.053** (0.017)	**-0.10** (0.03)	**-0.052** (0.017)	**-0.053** (0.017)
Conservative (5-point scale)	0.026 (0.018)	0.0024 (0.0082)	0.0010 (0.0083)	-0.0087 (0.0203)	-0.0069 (0.0092)	0.0010 (0.0083)
Obama won state	-0.00040 (0.03245)	-0.016 (0.016)	—	-0.00058 (0.03246)	-0.016 (0.016)	—
Obama won state × Democrat	**0.26** (0.04)	**0.11** (0.018)	**0.11** (0.02)	**0.25** (0.04)	**0.11** (0.018)	**0.11** (0.02)
Voting machine type (opscan omitted category)						
DRE	**-0.11** (0.03)	**-0.053** (0.016)	**-0.091** (0.027)	**-0.46** (0.10)	**-0.16** (0.05)	**-0.091** (0.027)
DRE × conservative scale	—	—		**0.11** (0.03)	**0.032** (0.014)	
Other equipment (punch card, lever machine, mixed)	**0.12** (0.05)	0.038 (0.023)	-0.047 (0.057)	**0.12** (0.05)	0.035 (0.023)	-0.047 (0.057)
Race (white omitted category)						
Black	**0.32** (0.07)	**0.16** (0.03)	**0.16** (0.03)	**0.34** (0.07)	**0.16** (0.03)	**0.16** (0.03)
Other race	-0.029 (0.057)	0.0031 (0.0248)	0.014 (0.026)	-0.032 (0.057)	0.0018 (0.0248)	0.014 (0.026)
Early voter	0.0048 (0.0419)	0.0061 (0.0191)	0.0026 (0.0219)	-0.0012 (0.0420)	0.0045 (0.0191)	0.0026 (0.0219)
Absentee voter	**-0.32** (0.04)	**-0.19** (0.02)	**-0.16** (0.02)	**-0.32** (0.04)	**-0.19** (0.02)	**-0.16** (0.02)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ordered probit	Regression	Regression (state fixed effects)	Ordered probit	Regression	Regression (state fixed effects)
Disabled voter	**-0.11** (0.04)	**-0.048** (0.020)	**-0.048** (0.020)	**-0.11** (0.04)	**-0.047** (0.020)	**-0.048** (0.020)
Intercept	—	2.76 (0.05)	2.78 (0.05)	—	2.79 (0.05)	2.78 (0.05)
Cut line 1	-0.37 (0.11)	—	—	-0.48 (0.11)	—	—
Cut line 2	0.13 (0.11)	—	—	0.01 (0.11)	—	—
Cut line 3	1.28 (0.11)	—	—	1.17 (0.11)	—	—
N	7,693	7,693	7,693	7,693	7,693	7,693
llf	-5288	—	—	-5281	—	—
(Pseudo) r^2	.09	.14	.14	.09	.14	.14
F-test for equality across states	—	—	F(48,7630) = 1.41 (p=.03)	—	—	F(48,7630) = 1.42 (p=.03)

Election Technology and the Voting Experience in 2008

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The Massachusetts Institute of Technology

Draft of March 25, 2009

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Election Technology and the Voting Experience in 2008

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The 2000 election brought the issue of voting machine performance to national attention. According to the Caltech/MIT Voting Technology Project (2001), up to 2 million votes were lost in 2000 owing to problems associated with faulty voting machines and confusing ballots. Stewart (2006) estimated that one million votes were "recovered" in the 2004 presidential election because of the Help America Vote Act's (HAVA) requirement that punch card ballots and lever machines be replaced by more modern optically scanned ballots and direct recording electronic (DRE) voting machines.

The role of technology in guarding the franchise in the United States has grown even more controversial since 2000. Most notably, a large number of computer scientists and election reform activists have identified what they perceive to be inherent security vulnerabilities associated with DREs (Mercuri 1992; Neumann 1985, 1990, 1993; Howland 2004; Dill 2003; Rubin 2003; Kohno, et al 2004). This alarm has spread more broadly to a large portion of the electorate, leading to efforts nationwide to ban electronic voting that lacks a "paper trail" (Alvarez and Hall 2008). More broadly, regular citizens, activists, and election professionals have become concerned with the performance of different voting technologies from a time-and-motion and/or human factor perspective. Among these concerns are issues like the lifetime cost of different technologies, the ease of use of technologies, and the throughput capacity of different types of voting machines.

Given the concerns that have been raised about the performance of voting technologies, it is remarkable how little empirical evidence has been adduced concerning the performance of

voting machines nationwide (Stewart 2008; Alvarez and Hall 2008; Gerken 2009). This is not to say that there is *no* evidence about voting system performance, only that the evidence is surprisingly thin. There is now a line of "residual vote" scholarship, which uses over- and under-votes as a proxy for the ease-of-use of different equipment (Ansolabehere and Stewart 2005; Herron and Sekhon 2005; Stewart 2006; Leib and Dittmer 2002; Ansolabehere 2002; Buchler, Jarvis, and McNulty 2004; Brady 2004; Kimball and Kropf 2005; Frisina, Herron, Honaker, and Lewis 2008). Some have studied human factors issues as they pertain to voting machines in experimental and quasi-experimental settings (Herrnson, et al; Everett, Byrne, Greene, and Houston 2006; Byrne, Greene, and Everett 2007; Lausen 2007). And yet others have used survey techniques to explore the satisfaction of voters with different types of voting technologies (Alvarez, Hall, and Llewelyn 2004, 2008).

The purpose of this paper is to add to the growing literature about how well voting technologies perform in elections, using survey research to gather direct voter feedback. In particular, I use the 2008 Survey on the Performance of American Elections, combined with data about the voting machines used by voters, to assess whether different machines led voters to experience more problems voting or to have less confidence in how elections were run in 2008.

I explore two issues that pertain to the voter experience and voter technologies. The first is whether users of specific voting machines encountered more problems than the users of other types of machines. Practically speaking, this reduces to the question of whether voters who used optical scanning technologies to vote had more (or fewer) problems than those who used DREs in 2008. The second issue is whether voter confidence in the quality of the vote-count varied with the use of different voting machines.

I find that voters who used both DREs and optical scanners had very few problems with voting equipment in 2008, and that the experience of both sets of voters was similar, as far as encountering problems is concerned. The one problem that affected users of voting machines at different rates was in how long they waited in line to vote. DRE voters waited an average of 21 minutes to vote on Election Day, compared to 12 minutes for optical scan voters. There is evidence that most of this difference was not due to the DREs themselves, but to the fact that DREs tend to be used more often in cities and communities that have large African American populations — areas that may already be suffering from problems with the delivery of government services.

I also find that users of DREs were less confident that their votes were counted as cast, compared to users of other voting equipment. There was also an interaction between political ideology and voting machine type in influencing one's confidence in the quality of the vote count. Liberal voters who used DREs were particularly skeptical that their votes had been counted as cast.

The rest of the paper proceeds as follows. First, I briefly describe the 2008 Survey of the Performance of American Elections. The following section explores the relationship between voting machine usage and the qualitative experience voting. Then I examine the influence that voting machine type had on voter confidence in the quality of the vote count. The final section concludes.

I. Survey Design

The primary data for this paper come from the 2008 Survey of the Performance of American Elections.[1] The purpose of the survey was to investigate a range of election administration issues nationwide in 2008. In order to facilitate comparisons, the number of interviews was constant in each state — 200. Therefore, the total number of observations in the entire data set is 10,000.

The survey was administered via the Internet by YouGov/Polimetrix. Full details of the survey may be found at Alvarez, et. al (2009). The survey went into the field the Wednesday following Election Day, finishing up within ten days.[2]

The most salient aspect of the survey that may be of concern in this paper is the fact that it was administered via the Internet. One goal of the entire project of which this paper is a part is to understand whether there are "mode effects" when conducting election administration surveys. To address the question about mode effects, the survey also involved a telephone portion, in which 200 respondents were interviewed in each of 10 states, using the same questionnaire. As a general matter, respondents to the Internet survey were slightly younger and wealthier than the phone respondents. For the most part, Internet respondents did not report dramatically different experiences voting than did Internet respondents. When they were different, it was usually because Internet respondents were more likely to report that their

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[1]Funding for this project was generously provided by the Pew Center on the States, the JEHT Foundation, and AARP. The funding agencies bear no responsibility for the analysis presented here.

[2]In preparation for the November 2008 survey, we also conducted two pilots, which studied the three gubernatorial elections that were held in November 2007 and the fifteen states that held primaries during Super Tuesday in 2008.

experiences were negative when they went to vote. While the comparison of the two modes still needs further investigation, it does not appear that the covariate patterns differ in the two modes. A fuller discussion of the differences between the Internet and telephone respondents is available in Alvarez, et al (2009).

II. Voting Machines and Problems at the Polls

The most basic question to explore is whether voters were more or less likely to encounter different problems voting, as a function of the voting machines they used. Voting machines themselves vary in their ease of use, which may show up in the survey responses (Herrnson, et al, 2008). Voting machines differ also in how they are deployed in precincts, and the resulting workflow required by one type of machine may have spillover effects on the voting experience. For instance, because DREs are much more expensive to purchase than optical scanners, it is much more expensive to add an additional voting station to a precinct that has DREs when turnout increases. That, in turn, could produce longer lines to vote in areas that use DREs, compared to areas that rely on optical scanners. Or, because optical scanners require pre-printed ballots, a mis-estimate of turnout could result in a shortage of ballots, a problem that does not vex DREs.

Therefore, I begin the analysis by asking simply whether users of different types of machines were more likely to encounter problems in 2008 of the following sort:

- having problems with the equipment itself
- finding it difficult to find the polling place
- encountering a poorly run polling place or a poorly performing poll worker

- encountering a voter registration problem
- waiting in a long line to vote

Table 1 provides measures of how often respondents encountered particular problems, as a function of the type of voting equipment they used. The voting equipment data were purchased from Election Data Services (EDS). EDS reports the voting machine used for in-person voting in each county in the U.S. Sometimes municipalities within a county will use a multitude of different types of voting machines. Because the voting equipment data are reported at the county level, respondents from these counties are recorded as voting on "mixed" machines in 2008. Finally, because I am interested in the machines used when voters vote in person, I confine the analysis to respondents who either voted on Election Day or who voted early at a walk-in early voting center.

[Table 1]

Table 1 tests whether the responses to questions about the different types of problems differed across voting machines, using a series of ANOVA analyses. The most obvious item to examine is whether users of different voting machines experienced problems at different rates. The "voting equipment problem" item is the only item in the table in which there were no differences across voting machines.

There were, at most, minimal differences in the rates of encountering problems across voting machine types, with one exception — waiting in line. Respondents who voted on DREs waited almost twice as long to vote as users of scanned paper ballots.[3] This confirms a concern

[3]The line length question was recoded, so that the response represented the nominal midpoint of the response category. For instance, respondents who stated they waited between 30 minutes and an hour are coded as waiting 45 minutes. Respondents who stated that they waited

some have raised about DREs, which is that they are often under-deployed where they are used, because of the cost, and that this results in longer lines and greater inconvenience for voters.

One question that arises with the issue of line length is *where* precisely the backup occurred. Lines may generally occur in two places at a precinct — at the table to check-in voters or at the machines themselves, after the voters have checked in but are waiting to gain access to a voting booth. Users of DREs may be doubly disadvantaged, since part of the check-in is the preparation of a Personal Electronic Ballot (PEB) card, which allows the voter to vote and renders the proper ballot style.

To probe this detail, the survey asked voters who had to wait in line, the following question: "Was your wait in line mostly when you first arrived to check in at the registration table, or after you checked in and were waiting to gain access to a place to cast your ballot?" A summary of answers to this question, by voting machine type, is given in Table 2.

[Table 2]

There were slight differences between DREs and optical scanners in where the lines occurred. Lines were a little more likely to appear gaining access to the ballot/voting station with optical scanners than with DREs. However, the difference was substantively very small, and unlikely to be the source of the big differences encountered in waiting to vote.

African Americans waited in line twice as long to vote, compared to whites. The average reported wait was 27 minutes for Blacks and 13 minutes for Whites. This is not a difference

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"longer than an hour" to vote were coded as having waited 122 minutes. The coding of 122 minutes was chosen for the top category because respondents picking this response were prompted to report precisely how many minutes they waited. The average of these open-ended responses was 122 minutes.

unique to 2008. It showed up in the two pilot studies associated with this project. In the three states studied in the gubernatorial elections in November 2007 (Kentucky, Louisiana, and Mississippi), Blacks waited an average of 6 minutes to vote, compared to 2 minutes for whites. In the fifteen states studies on Super Tuesday, Blacks waited an average of 5 minutes to vote, compared to 4 minutes for Whites. And in the 2006 CCES, Blacks waited an average of 12 minutes to vote, compared to 7 minutes for Whites.

For some, this is a sign of how poorly African American communities are served by election administrators, as is often true with other government services. However, African Americans were more likely to vote on DREs in 2008 than Whites. While I have not examined the situation for the earlier elections covered by this project or in 2006, it is likely that African Americans were more likely to vote on DREs in these elections, too. Therefore, the racial difference observed in this and prior studies, and reported widely by the press, may really be a story about DREs, not racial discrimination, *per se.*

To understand whether racial disparities in waiting in line to vote were due to the disproportionate use of DREs by African Americans, I conducted a simple multivariate regression analysis that predicted the amount of time waiting to vote as a function of the racial composition of the respondent's ZIP code and the population density of the ZIP code. The results are reported in Table 3. The analysis is confined to voters who voted on Election Day who used either DREs or optical scanners.

[Table 3]

The first three columns of Table 3 reveal the bivariate regression coefficients. In the multivariate regression (column 4), the size of the DRE coefficient falls by roughly one-third,

while the coefficients associated with the racial composition of the neighborhood and its density fall by much smaller amounts. Finally, in the regression that introduces state-level fixed effects, the DRE coefficient is cut in half, and the coefficient now does not meet the $p < .05$ criterion. The other two coefficients change by much smaller amounts.

What this suggests is that the racial effect is fairly robust, whereas the DRE effect is most likely due to the use of DREs in predominantly African-American areas and in cities. The reduction in the coefficient's size when we introduce state-level fixed effects also suggests that the bivariate DRE effect may be mostly due to other factors that figure into how states that allow DREs manage their elections.

III. Voting Machines and Voter Confidence

In addition to understanding whether voting machines get in the way of voters trying to express their preferences, the machines themselves have become the target of political controversy. At the activist level the debate has largely arrayed along a left-right continuum, with the left being highly suspicious of DREs — and in some cases, even of the scanners used to read optically scaned ballots — and the right ranging from indifference to mild support for DREs. Distrust on the left has spilled over into voter mobilization efforts, as some activists have encouraged Democratic supporters to vote absentee, on a paper ballot, rather than on a hackable "black box" machine.

We can use the survey to test the degree to which the ideological battle over voting machines has percolated down to voters. The survey asked all respondents "How confident are you that your vote in the General Election was counted as you intended?" The response

categories were “very confident,” “somewhat confident,” “not too confident,” and “not at all confident.”

A simple glance at the marginals suggests that if there was an influence of voting equipment on voter confidence in 2008, it was subtle. Table 4 reports the breakdown of responses to the confidence question by type of voting machine used. The differences between users of DREs and optical scanners are tiny and not statistically significant. The large difference that exists in that table is between DRE and optical scan users, on the one hand, and users of all other voting equipment, on the other. The “other” category consists of voters who used legacy systems (lever machines and hand-counted paper), plus respondents who lived in counties that used several voting machine types, which were primarily in New England and Wisconsin. Voters in these counties were considerably more confident that their ballots would be counted as cast, compared to voters who lived in counties that only used DREs or only used optical scanners.

[Table 4]

Table 5 explores whether confidence in DREs was a function of ideology. The evidence here is decidedly mixed. The most extreme ideologues actually contradict the expected pattern: “very conservative” users of DREs were *less* confident their vote was counted as cast than “very liberal” respondents. On the other hand, the plain vanilla liberals and conservatives seemed to fit the expected pattern, with liberal DRE users less confident than conservatives.

[Table 5]

Thus, a look at Tables 4 and 5 suggests that voter confidence in the count was complicated by a number of factors, including the geographic location of the voters and their

personal characteristics. If we are to find the effects of machine usage on confidence in the quality of the vote count, we need to shift to a multivariate context.

The multivariate analysis is guided by Alvarez, Hall, and Llewelyn (2008), who studied voter confidence in the 2004 election as a function of various personal demographic and political characteristics, in addition to the type of voting machine used by the voter. In that analysis, users of DREs were less confident their vote had been counted as cast, compared to those who voted on paper (mostly optical scan). Alvarez, Hall, and Llewelyn also asked respondents about their opinions of electronic voting. Not surprisingly, DRE voters who also had negative general opinions about electronic voting were *especially* skeptical that their votes were counted as cast.

The variables available to use in this analysis are not precisely those available to Alvarez, Hall, and Llewelyn. Most importantly, we do not have a direct measure of the attitudes that the respondents had toward electronic voting, *per se.* However, we did ask respondents a battery of questions to probe their attitudes about how prevalent voting irregularities were in their community. I used this battery of questions to control for general attitudes about the quality of election administration in the respondent's community.

The dependent variable was the response to the "confidence question" discussed above. It was coded so that a value of 4 corresponded with "very confident" and 1 corresponded with "not at all confident."

The demographic controls were the following:

- *age*, measured in years.
- a dummy variable equal to 1 if the respondent was *male*, zero otherwise.

- *education*, measured using a six-point scale ranging from "did not graduate high school" to "post-graduate."[4]
- *black* and *other race* dummy variables, leaving white respondents the excluded category.
- *disabled*, a dummy variable equal to 1 if the respondent stated that she or he had a health problem, disability, or handicap that kept the respondent from "currently participating fully in work, school, housework, or other activities," zero otherwise.

The control for attitudes about the honesty of local elections was constructed by using three items that asked respondents how frequently they thought voter fraud, vote theft, and voter impersonation occurred in their community. Responses were recorded on a four-point scale, ranging from "it is very common" to "it almost never occurs."[5] These three items were summed to create a scale labeled *trust*, normalized to range from 1 to 4. A value of 1 was assigned to respondents who said that all three problems were "very common" (4% of respondents) to 4, for those who said that all three problems "almost never occurred" (39% of respondents).

The political controls consisted of a mix of straightforward measures of respondent affiliations, along with variables intended to capture the interaction of the respondent's political affiliations with the outcome of the election. The political controls were the following:

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[4]The coding was 1 = did not graduate high school, 2 = high school graduate, 3 = some college, 4 = graduated with an associates degree, 5 = graduated with a bachelors degree, 6 = post-baccalaureate degree.

[5]The modal response for the voter fraud item was "it occurs occasionally" (23% of respondents); the modal response for the other two items was "it almost never occurs" (54% for vote theft and 55% for voter impersonation).

- *democrat,* coded to equal 1 for those identifying as Democrats, 0 for those identifying as independents, and -1 for those identifying as Republicans.
- *conservative,* a five-point scale ranging from 1 for those who described themselves as "very liberal" to 5 for those who described themselves as "very conservative." To preserve degrees of freedom, respondents who stated that they did not know their ideology were assigned a value of 3. The substance of the analysis does not rest on this choice, but it does affect the size of the standard errors.
- *Obama won the state*, coded to equal 1 if Barack Obama carried the respondent's home state, zero otherwise.
- an interaction term of *democrat* × *Obama won the state.*

The last variable was intended to control for respondents tending to trust the vote count more when their candidate won than when she or he lost. My expectation is that Democrats in states that Obama won will be more confident that their vote was counted as cast and that Republicans in these states will be more likely to doubt whether their vote was counted as cast.

Our dataset included people who voted on Election Day (63%), voted at early voting centers (18%) or by mail/absentee (19%). Alvarez, Hall, and Llewelyn found that absentee voters were less confident their votes had been counted as cast than in-person voters. Therefore we included two dummy variables to indicate the mode of voting in the general election, as follows:

- *absentee,* a dummy variable equal to 1 if the respondent voted absentee or by mail (i.e., in Oregon), zero otherwise.

- *early voter*, a dummy variable equal to 1 if the respondent voted early, zero otherwise.

The omitted category for these two dummy variables was respondents who voted in person on Election Day.

From the perspective of studying the influence of voting technology on voter confidence it is important to control for voting absentee, since absentee voters all use paper ballots, regardless of the mode of voting for in-person voters. Seen another way, the absentee ballot control allows us to separate out the effect of voting in person on optically scanned paper from the effect of using paper as an absentee mode.[6]

Finally, we include dummy variables to account for the type of in-person voting machine used in the county of the respondent. Unlike Alvarez, Hall, and Llewelyn, who asked respondents which type of voting machine they used, this analysis relies on data collected by Election Data Services. In addition to the obvious advantage of not having to rely on voter recall, relying on independent data measuring the voting machine used means that we can distinguish between respondents who voted on hand-counted paper ballots from those who voted on scanned paper ballots. The disadvantage is that we cannot analyze precisely voters who lived in counties that use DREs in some municipalities and paper ballots (scanned or hand-counted) in others.

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[6]Getting ahead of the analysis, absentee voters in counties that use DREs for in-person voting expressed no different confidence levels compared to other absentee voters, suggesting that attitudes associated with confidence in the election are not big motivators among those voting absentee.

Specifically, we entered two dummy variables into the analysis to account for voting machine type, leaving the optically scanned option as the omitted category:

- *dre,* equal to 1 if the county used DREs for in-person voting, zero otherwise.
- *other equipment,* equal to 1 if the county used mechanical lever machine, hand-counted paper, or a mix of equipment, zero otherwise.

Rather than simply satisfying idle curiosity, the introduction of the controls is intended to lend precision to the estimates of the voting machine effects. Therefore, it is useful to know how the controls correlated with the voting machine indicators. Based on a multivariate regression (coefficients not reported), DREs were more likely to be used by conservatives and by African Americans, and less likely to be used by states won by Obama, and by members of other races (mostly Hispanic). Users of the "other equipment" category (mostly voters in New England and Wisconsin whose counties used multiple equipment) tended to be most trusting of the results, older, Republican, liberal, and in states won by Obama. They were less likely to have voted early or absentee.

Therefore, the controls introduced should help to remove a host of confounding effects that interfere with getting a clear view of how voting technology influenced attitudes about whether the election was fairly decided.

Table 6 reports the results of the multivariate analysis. Because we are analyzing a discrete four-point scale that is clearly measuring values along a continuous latent variable, the first column uses an ordered probit analysis to study the effects. Column (2) reproduces the ordered probit analysis with OLS regression. Column (3) repeats this regression using state-level fixed effects.

[Table 6]

Leaving aside the voting machine issue for the moment, the demographic factors provide an interesting portrait of attitudes toward the outcome of the 2008 election. Respondents who were the most confident that their vote was counted as cast were (1) trustful that their local elections were clean, (2) older, (3) male, (4) well-educated, (5) Republicans, (6) African American, and (7) Democrats in states won by Obama or Republicans in states won by McCain. With one important exception, these results are consistent with those found by Alvarez, Hall, and Llewelyn. (Alvarez, Hall, and Llewelyn did not interact party with the winner of the state, however.) That exception pertains to race. In 2004, African Americans were substantially less likely to trust that their vote had been counted as cast; in 2008, they were substantially *more* confident that their vote was counted as they had cast it.

Turning to voting machines, we find that DRE-users were less confident in the quality of the vote count than users of other technologies. Again, this is consistent with the 2004 findings. Unlike the 2004 study, however, users of other voting machines were *more* confident than users of optical scanners. This remains true if we distinguish those who voted on hand-counted paper or lever machines from the grab bag "mixed" category. (Additional analysis not reported.)

One problem with the mixed category is that it may really be just an additional control for voters who lived in the Northeast and Wisconsin. To explore whether the mixed category is simply a half-hearted attempt at dummying-out individual states, I conducted a fixed-effects regression. When we do that in column (3), the results are materially the same as before, which gives me greater confidence in the results reported in the first two columns.

Alvarez, Hall, and Llewelyn reported a strong interaction between using DREs and opinions about electronic voting. While the current survey did not have a parallel question, we can treat ideology as a (weak) proxy for attitudes toward electronic voting. Therefore, I repeated the prior analysis, this time adding an interaction between the ideology measure and the indicator of DRE use. The results (reported in columns 4–6 in Table 6) are consistent with Alvarez, Hall, and Llewelyn's findings. Conservatives voting on DREs were much more confident than liberals who used them.

Keep in mind that the coefficient associated with DREs in column 4 is a combination of the direct effect and the interaction effect of ideology. For a strong conservative, therefore, the estimated probit coefficient value is $-0.46 + 5 \times 0.11 = 0.09$. For a strong liberal, the coefficient takes on a value of $-0.46 + 1 \times 0.11 = -0.35$. Thus, it is fair to say that liberals who voted on DREs were negative about their assessment of whether their vote would be counted. Conservatives, on the other hand, were largely indifferent.

IV. Conclusions

This paper confirms a growing body of research that shows that voting machines are not neutral transmission belts of voter preferences to election outcomes. Some voting machines are easier to use than others. Some voters are more convinced that certain machines are more fair than others.

Yet to note that voting technologies are not neutral is not the same thing as saying that they determine outcomes, nor does stating that voting technologies harbor shortcomings constitute a blanket indictment of elections in America (c.f. Gerken 2009). As far as voters

themselves perceive it, their experience in 2008 was very positive. The problems that they identified are focused on particular areas.

Responses to the 2008 Survey of the Performance of American Elections suggest that one place to focus is on lines at voting precincts. Users of DREs waited longer to vote in 2008 than users of optically scanned ballots, which seems to confirm criticisms leveled by opponents of DREs, who have claimed that they inherently are prone to producing back-ups. However, the detailed analysis provided in this paper suggests that the lines associated with DREs are an indicator of an even bigger problem, which is that the lines themselves seem to arise from the administrative problems facing voters in African American communities, which are more likely to have DREs.

Understanding whether longer lines associated DREs are caused by the machines themselves or by factors related to the demographic characteristics of DRE users, is critically important for the task for improving customer service in elections. A danger of simply observing that DREs are associated with longer lines is that election officials, reformers, and regular citizens might be moved to ditch DREs in favor of optically scanned paper ballots. However, if the analysis provided by this paper is accurate, then such a move would not reduce lines very much for African Americans. More important is understanding why African Americans stand in line to vote longer than whites, regardless of the machines they vote on. It is likely that major progress in reducing the lines at polling places will occur only when customer service problems associated with running polling places in African American communities are eliminated for users of all voting technologies.

This paper also confirms that the partisan polarization around the fairness of election administration may have diminished in 2008, but it hasn't disappeared altogether. The Pew Research Center for the People and the Press reported that voters in 2008 were substantially more likely to believe their vote would be accurately counted than voters in 2004, and that the partisan differences in answering this question had disappeared.[7] However, as the results of the survey analyzed in this paper demonstrate, distrust over electronic voting machines still lurks, especially among liberals who are required to use DREs. It is way too early to tell whether confidence in the vote count will continue to vary depending on the party of the winner, or whether distrust of DREs will continue to be structured along ideological lines. It is reasonable to suspect that in the next federal election in which Republicans do well, liberal distrust of DREs could return.

Gauging the performance of the election system is an important undertaking for the profession of political science. As this paper shows, common perceptions about the contours of problems facing voters may in fact be inaccurate, and thus popular proposals can easily miss the mark. In the future, as other national studies of the election process are undertaken, one can hope that systematic empirical tools will replace anecdote in identifying the nature of the problems facing voters and the most effective solutions.

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[7]The Pew Center for the People and the Press, "High Marks for the Campaign, a High Bar for Obama," November 13, 2008, http://people-press.org/report/471/high-bar-for-obama, accessed March 28, 2009.

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Table 1. Election problems and voting machine type, among voters who voted early in-person or on Election day. (Number of observations in parentheses.)

	Voting equipment problem (yes)	Finding polling place (very difficult or somewhat difficult)	How well polling place run (terrible or not well)	Voter registration problem (yes)	Line length (minutes)	Poll worker performance (poor or fair)
Punch cards	0 (10)	0 (10)	4.1% (10)	4.1% (10)	8.7 (10)	4.1% (10)
Lever machine	2.7% (507)	2.3% (506)	1.2% (506)	3.4% (507)	8.6 (507)	8.0% (506)
Paper	0 (16)	0 (15)	0 (15)	2.9% (16)	1.9 (16)	0 (15)
Scan	1.8% (4,054)	2.2% (4,063)	2.1% (4,059)	2.1% (4,053)	12.4 (4,053)	5.5% (4,057)
DRE	2.3% (2,657)	2.0% (2,561)	1.7% (2,562)	1.8% (2,570)	21.1 (2,570)	4.1% (2,567)
Mixed	1.6% (444)	0.8% (443)	0.9% (443)	0.93% (445)	6.7 (445)	3.6% (442)
Total	2.0% (7,597)	2.0% (7,598)	1.9% (7,595)	1.9% (7,601)	14.7 (7,601)	5.1% (7,598)
F	(5,7591) = .87 (p = .4975)	(5,7592) = 3.81 (p = .0019)	(5,7589) = 3.33 (p = .0053)	(5,7595) = 1.56 (p = .1673)	(5,7602) = 52.57 (p < .0001)	(5,7592) = 2.94 (p = .0119)

The columns are defined as possible:
1*Voting equipment problem* = percentage of respondents reporting a problem with the voting equipment.
2*Finding polling place* = percentage of respondents who reported that finding the polling place was “very difficult” or “somewhat difficult”
3*How well polling place run* = percentage of respondents who reported that the polling place was run “terribly” or “not well.”
4*Voter registration problem* = percentage of respondents who reported a voter registration problem.
5*Line length* = average number of minutes the respondent waited in line to vote.
6*Poll worker performance* = percentage of respondents who reported that the poll worker performance was “poor” or “fair.”

Table 2. Source of lines, by voting machine type.

	Check-in to vote	After checking in	Fairly evenly divided	N
Punch cards	68%	17%	15%	20
Lever machines	41%	36%	23%	108
Paper	30%	58%	12%	9
Scan	67%	16%	17%	2,107
DRE	59%	22%	19%	1,824
Mixed	77%	8%	14%	332

Question: Was your wait in line mostly when you first arrived to check in at the registration table, or after you checked in and were waiting to gain access to a place to cast your ballot?

<1> Most of my wait was to check in to vote.

<2> Most of my wait was after I had checked in, and I was waiting to gain access to a voting machine or other place to vote.

<3> My wait in line was fairly evenly divided between checking in and waiting to cast my ballot.

Table 3. Line length on Election Day as a function of voting machine used by respondent, racial composition of ZIP code, and population density of ZIP code. (Note: Confined to users of either DREs or opscans)

	(1)	(2)	(3)	(4)	(5)
Used DRE	6.12 (0.84)	—	—	4.74 (0.82)	2.41 (1.44)
Black percentage	—	32.72 (2.14)	—	28.52 (2.21)	21.85 (2.37)
log(population density)	—	—	1.88 (0.23)	1.11 (0.23)	1.97 (0.25)
Constant	13.35 (0.54)	12.02 (0.48)	3.73 (1.51)	3.37 (1.52)	-0.44 (1.71)
R^2	.01	.05	.02	.06	.14
N	4,573	4,573	4,573	4,573	4,573
State fixed effects	No	No	No	No	Yes

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Table 4. Confidence that vote was counted as cast, by type of voting equipment used (Election Day and early voters).

	Not at all confident	Not too confident	Somewhat confident	Very confident	N
DRE	2.1%	3.3%	23.3%	71.3%	2,541
Scan	2.0%	2.8%	21.2%	74.1%	3,995
Other	1.0%	3.2%	17.7%	78.2%	970
Total	1.9%	3.0%	21.4%	73.7%	7,506

Table 5. Confidence that vote was counted as cast, by ideology, for those using DREs.

	Not at all confident	Not too confident	Somewhat confident	Very confident	N
Very liberal	0.8%	1.1%	24.9%	73.2%	190
Liberal	2.2%	3.8%	26.7%	67.3%	391
Moderate	1.7%	3.6%	23.0%	71.7%	1,031
Conservative	3.2%	2.4%	19.3%	75.1%	658
Very conservative	2.4%	4.3%	27.1%	66.3%	354
Total	2.2%	3.3%	23.3%	71.3%	2,623

Table 6. Trust and confidence. Probability that respondent was "very confident" vote was counted as cast. Coefficients that are significant at the 95% level are in **bold**.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ordered probit	Regression	Regression (state fixed effects)	Ordered probit	Regression	Regression (state fixed effects)
Election honesty scale	**0.42** (0.02)	**0.21** (0.01)	**0.21** (0.01)	**0.42** (0.02)	**0.21** (0.01)	**0.21** (0.01)
Age (years)	**0.0089** (0.0011)	**0.0037** (0.0005)	**0.0037** (0.0005)	**0.0089** (0.0011)	**0.0038** (0.0005)	**0.0037** (0.0005)
Male	**0.11** (0.03)	**0.058** (0.014)	**0.058** (0.014)	**0.11** (0.03)	**0.057** (0.014)	**0.058** (0.014)
Education (6-point scale)	**0.027** (0.011)	0.0093 (0.0048)	0.0093 (0.0048)	**0.027** (0.011)	0.0092 (0.0048)	0.0093 (0.0048)
Democrat (3-point scale)	**-0.10** (0.03)	**-0.054** (0.017)	**-0.053** (0.017)	**-0.10** (0.03)	**-0.052** (0.017)	**-0.053** (0.017)
Conservative (5-point scale)	0.026 (0.018)	0.0024 (0.0082)	0.0010 (0.0083)	-0.0087 (0.0203)	-0.0069 (0.0092)	0.0010 (0.0083)
Obama won state	-0.00040 (0.03245)	-0.016 (0.016)	—	-0.00058 (0.03246)	-0.016 (0.016)	—
Obama won state × Democrat	**0.26** (0.04)	**0.11** (0.018)	**0.11** (0.02)	**0.25** (0.04)	**0.11** (0.018)	**0.11** (0.02)
Voting machine type (opscan omitted category)						
DRE	**-0.11** (0.03)	**-0.053** (0.016)	**-0.091** (0.027)	**-0.46** (0.10)	**-0.16** (0.05)	**-0.091** (0.027)
DRE × conservative scale	—	—		**0.11** (0.03)	**0.032** (0.014)	
Other equipment (punch card, lever machine, mixed)	**0.12** (0.05)	0.038 (0.023)	-0.047 (0.057)	**0.12** (0.05)	0.035 (0.023)	-0.047 (0.057)
Race (white omitted category)						
Black	**0.32** (0.07)	**0.16** (0.03)	**0.16** (0.03)	**0.34** (0.07)	**0.16** (0.03)	**0.16** (0.03)
Other race	-0.029 (0.057)	0.0031 (0.0248)	0.014 (0.026)	-0.032 (0.057)	0.0018 (0.0248)	0.014 (0.026)
Early voter	0.0048 (0.0419)	0.0061 (0.0191)	0.0026 (0.0219)	-0.0012 (0.0420)	0.0045 (0.0191)	0.0026 (0.0219)
Absentee voter	**-0.32** (0.04)	**-0.19** (0.02)	**-0.16** (0.02)	**-0.32** (0.04)	**-0.19** (0.02)	**-0.16** (0.02)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ordered probit	Regression	Regression (state fixed effects)	Ordered probit	Regression	Regression (state fixed effects)
Disabled voter	**-0.11** (0.04)	**-0.048** (0.020)	**-0.048** (0.020)	**-0.11** (0.04)	**-0.047** (0.020)	**-0.048** (0.020)
Intercept	—	2.76 (0.05)	2.78 (0.05)	—	2.79 (0.05)	2.78 (0.05)
Cut line 1	-0.37 (0.11)	—	—	-0.48 (0.11)	—	—
Cut line 2	0.13 (0.11)	—	—	0.01 (0.11)	—	—
Cut line 3	1.28 (0.11)	—	—	1.17 (0.11)	—	—
N	7,693	7,693	7,693	7,693	7,693	7,693
llf	-5288	—	—	-5281	—	—
(Pseudo) r^2	.09	.14	.14	.09	.14	.14
F-test for equality across states	—	—	F(48,7630) = 1.41 (p=.03)	—	—	F(48,7630) = 1.42 (p=.03)